STAYING ONE STEP AHEAD

Marc Seeger, Chris Broekmeulen and Sebastian Ruik Beyhaut, ROSEN Group, present a comprehensive asset integrity management solution for tank farms.

Figure 1. Inspecting the floor of a storage tank using ROSEN's tank bottom inspection tool (TBIT).

In order to reduce economic and environmental risks resulting from product loss, periodic tank inspection and maintenance activities are of upmost importance. Combining state of the art inspection technologies and information management tools allows operators to achieve the dual goal of asset integrity and long service life. This article presents a comprehensive asset integrity management solution covering the complete asset life cycle.

Integrated engineering solutions for tank farms require specialised knowhow and a wide range of resources. As assets age, inspection activities typically increase and maintenance requirements can become demanding.

A combined solutions approach

Generally speaking, tank farms and their components are susceptible to material failure and all sorts of defects throughout their service life. While any asset integrity problems can lead to dangerous situations and unplanned downtime, uncontrolled corrosion in particular can weaken or destroy

Figure 2. Radio controlled, waterproof, and free climbing, Rosen's tank inspection crawler performs a wide range of tank wall inspections.

Figure 3. A gyroscopic balanced laser head is used to perform laser profiling services.

components and thus cause environmental contamination and volume losses with potentially very damaging economic effects.

To help operators prevent failures of any type and ensure compliance with local regulations, standards and codes, Rosen provides a full range of services worldwide. As part of a combined solutions approach, the condition of all equipment is first established on the basis of multi disciplinary engineering analysis (non destructive testing: NDT). The results of these inspection activities are then evaluated with sophisticated software solutions, which even provide supporting engineering and consultancy recommendations.

This combined solutions approach directly assists operators in making asset related decisions, for example as to whether a given asset should continue to be operated as it is, whether repairs or alterations are required, or if it is best to retire the equipment altogether. A remaining life analysis is usually performed as part of these supporting solutions as a basis for determining future inspection intervals and for budgeting capital expenditure. Due to the clear recommendations for corrective actions and remediation of this transparent process, auditability of the used asset integrity management system is significantly enhanced.

Asset integrity management

Asset integrity management denotes the process of coordinating activities and practices through which an organisation implements its organisational strategic plan. The main goal of asset integrity management is to optimise the performance of assets throughout their lifecycle. Most operators have some form of asset integrity management programme in place. However, due to increased regulatory supervision, growing operating costs and limited resources, the implementation of a fully compliant programme has become more and more challenging in recent times. To help operators overcome this challenge, Rosen's experts have developed support tools for qualitative and quantitative data management. By facilitating asset related decision making, these support tools make a vital contribution to the establishment of a preventive maintenance regime and hence to asset safety and security.

Non-destructive testing

Large chemical and petroleum product storage tanks can be found in a variety of industries such as chemical processing, refinery and manufacturing. Huge metal structures made of welded steel plates, such tanks are typically up to 150 ft in dia. and 50 - 60 ft tall and easily able to hold more than 2 million gal. of gas or other hazardous liquids. Although the material and the welds are checked for manufacturing defects upon construction, tanks must be periodically inspected for signs of damage throughout their service life. After all, carbon steel is prone to corrosion, and in some circumstances cracks can form over time. Any changes must be evaluated, documented and analysed in an empirical way.

Due to the complexity of reliable tank integrity management, the API (more specifically API Publication No. 653) and EEMUA (especially Publication No. 159) to some extent assist tank owners by providing guidelines for the maintenance, inspection and repair of conventional storage tanks in order to minimise in service problems. This risk reduction is achieved by a thorough explanation of important aspects of the inspection process (including rejection criteria), notably:

- Tank roof evaluation.
- Tank shell evaluation.
- Tank bottom evaluation.
- Tank foundation evaluation.
- Tank appurtenances.

To ensure that these requirements are properly interpreted and understood, comprehensive guidance is given on many key design features and on common problems experienced during operation and repair processes.

Despite these detailed guidelines, the concrete benefits of these guidelines for individual tank owners are, depending on the specific features of assets, not always clear. Even where the tasks and goals of integrity management are well understood, sound judgment is required on all elements of storage tank structure, foundation and operation to guarantee the structural integrity of above ground conventional e.g. hydrocarbon storage tanks. To achieve the required level of integrity for the next service period and beyond and carry out all inspections on a cost effective basis, tank operators often require the help of specialised (tank) inspection companies who provide specialised knowledge of tank engineering and asset management and a wide range of NDT methods to gather data on the condition of assets.

Thorough NDT of storage tanks involves visual observation and stream monitoring and makes use of priorities set by existing inspection records. Techniques such as acoustic emission (AE) can be used to get a first impression of the extent of tank bottom corrosion and to detect leaks in the bottom plates as a basis for deciding whether it is necessary to decommission the tank. However, inspection activities must go beyond simple thickness measurements, floor scanning and other forms of examination such as dye penetrant inspection (DPI) or magnetic particle inspection (MPI). Useful though these inspection methods are, the final inspection results require assessment by a competent engineer familiar with tank design and stress analysis. This engineer must then define the necessary levels of structural integrity to be maintained until the next major inspection, including the inner and outer part, the floor, the roof and the walls of the tank.

A good example of a tool incorporating NDT, Rosen's tank bottom inspection tool (TBIT) combines two distinct technologies: magnetic flux leakage (MFL) and eddy current (EC) (Figure 1). Whereas MFL is used to detect and size corrosion defects, EC helps determine the precise location of flaws within steel bottom plates, notably whether they are on the topside or the bottom side of the inspected plate. EC also provides lift off information, for example regarding the thickness of coating and amount of debris etc. This lift off information is also used to improve the sizing quality and the reliability of the MFL inspection results. The self contained and battery powered unit does not require any cables and is operated by a survey technician. Due to its compact design, the tool is ideally suited for obtaining high resolution metal loss data on tank plates including annular plates and in the regions close to plate welds. In addition, the remote control function of the TBIT permits inspection of restrictive installations (e.g. underneath heating coils and piping etc.)

For wall inspections, the tank inspection crawler, a radio controlled waterproof, free climbing inspection crawler, can be used (Figure 2). With this tool, Rosen can perform a variety of inspections even in the most inaccessible parts of assets.

Gathering information by means of a gyroscopic balanced laser head, a laser profiling service provides accurate and reliable geometrical data regarding movement and position of the tank, notably on the tank bottom profile, tank shell deformations and settlement of the tank as a whole (Figure 3). The profile inspection is fully integrated with a tank bottom mapping survey. Overall, by expertly combining various state of the art NDT methods to maximise inspection accuracy, reliability and efficiency, comprehensive and reproducible data complying with the pertinent regulations can be obtained on entire storage tank systems.

Centralised data management environment

As part of a well balanced and successful asset integrity management programme, the surfeit of inspection data collected with cutting edge NDT methods must be efficiently stored, analysed, prioritised and retrieved. In order to help operators manage large quantities of data and keep track of interconnected sets of activities and procedures executed as part of their asset integrity management programme, Rosen has developed a highly flexible, modular suite of software tools: asset integrity management software (ROAIMS) for tanks (Figure 4). ROAIMS for tanks was designed following a tested and proven approach to asset integrity management. Its streamlined design offers a range of applications that simplify data organisation, task planning/scheduling, inspection data management and reporting to meet both internal and external requirements and hence improve asset integrity. In addition, this user friendly suite enables easy customisation to suit operator needs as well as straightforward and cost effective implementation of remedial action. With these extremely useful functions, ROAIMS for tanks makes the whole inspection, maintenance and repair process transparent and manageable.

ROAIMS for tanks provides operators with a single comprehensive database to efficiently integrate and manage information relevant to the safe and economical operation of above ground storage tanks and related infrastructures. The software incorporates ISO 9000 and PAS 55 requirements with respect to analysis and data handling. The suite of modules consists of both asset independent and specialised tank integrity applications. Within ROAIMS, a central document repository allows the integration of documents, pictures and reports. This detailed documentation of all conducted integrity assessments constitutes an easily traceable up to date history of the overall integrity management process, thereby making it easy for tank operators to cross check all collected inspection results against the relevant standards and criteria. Allowing operators to define specific authorisation levels, this highly useful ROAIMS tool furthermore supports operators in their day to day work by ensuring that employees are able to execute only the functions in which they specialise and only for the assets assigned to them. In addition, ROAIMS software provides experts with visualisation tools for analysing available data, for example historical inspection and maintenance records, which enable well founded decisions about the required type and frequency of inspections and repairs.

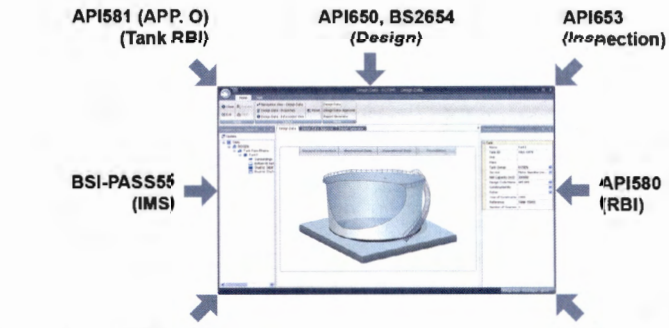

Figure 4. Schematic representation of the structure of ROAIMS for tanks.

Risk based inspections (RBI)

With ROAIMS for tanks, users can implement a risk based inspection programme, which is supported and organised by Rosen engineers and follows an implementation approach based on API 580. Many tank operators are now faced with the dilemma of having to maximise risk mitigation to improve safety and reliability, while at the same time under constant pressure to reduce operating costs to the greatest possible extent. To help operators optimally balance the opposing goals of low cost and minimal risk, Rosen offers RBI for the development of a cost effective inspection and maintenance programme that provides assurance of acceptable mechanical integrity and reliability. RBI analyses the likelihood of failure and its consequences. Items with high probability and high consequences are given a higher priority for inspection than items that are high probability but for which failure has low consequences. The final goal is to help tank operators define priorities for their NDT inspection runs by focusing their inspection and maintenance resources on the items/parts that contain the highest risks.

Conclusion

The combination of increasing environmental concerns and more stringent regulations has led to an intensification of preventive maintenance schedules for storage facilities. The reliable and sophisticated equipment provided by Rosen offers an innovative solution for tank integrity and risk management. On the one hand, the company offers sophisticated NDT technology and highly educated service engineers to inspect and analyse above ground storage tanks in compliance with the pertinent regulations. On the other hand, the highly flexible modular suite of software tools ROAIMS for tanks is available. Allowing customised and cost effective data management and easy implementation of maintenance and repair regimes, ROAIMS makes the whole asset integrity management process transparent and manageable. The ultimate goal of the tools and services offered is to strike an optimal balance between risk mitigation and cost reduction, thereby helping operators to stay one step ahead of integrity problems at all times. This management support tool has a strong focus on ownership, responsibilities, authority and skills for maintenance activities essential to the integrity/reliability of storage tanks. HE